# Artificial Magnetic Activity of Dielectric Photonic Crystals

D. Felbacq (1), G. Bouchitté (2)
(1) Groupe d'Etude des Semi-Conducteurs UMR-CNRS 5650.
Bat. 21, Place E. Bataillon, 34095 Montpellier Cedex 05, France
(2) Department of Mathematics, Université de Toulon,
BP 132 - 83957 La Garde Cedex, France

Below a cut frequency, wire mesh photonic crystals can be described by a negative permittivity given by $\varepsilon = 1 - 2\pi\gamma / k^2$. Recently, Pendry and co-authors suggested that it was possible to design photonic crystals exhibiting an artificial magnetic activity [1]. It is believed that, mixing both geometries, it is possible to obtain a material with both negative permittivity and permeability. It seems however that there be no unified theoretical approach to this kind of effective behavior. We address this problem in the case of dielectric fibers by using a renormalization group analysis. We show that the artificial magnetism is due to microscopic magnetic moments induced by geometric resonances. The relative permeability is obtained explicitly in the form: $\mu = 1 + k^2 \sum_n \frac{\alpha_n}{k_n^2 - k^2}$ [2]. Our result explains the apparent paradox raised by Pokrovsky et al. [3] that, by embedding wires in a medium with negative $\mu$, one does not get a Left Handed Medium.

[1] Pendry J B, Holden A J, Robins D J and Stewart W J, *IEEE Trans. Microw. Theory Tech.* **47**, 2075 (1999).
[2] D. Felbacq, G. Bouchitté, to be published in *Phys. Rev. Lett.,* ArXiv:physics/0412094.
[3] A. L. Pokrovsky and A. L. Efros, *Phys. Rev. Lett.* **89**, 093901 (2002).